Electric Circuits II – Assignment

02 - Source Free RL circuit, Singularity functions

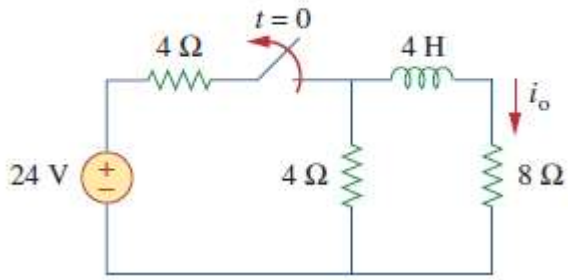
#	Student ID	Student Name	Grade (10)
-			

Delivery Date	

١. يتم تسليم التمرين محلولا في خلال أسبوع من تاريخ التمرين، و يتم حذف درجتين من التمرين عن كل أسبوع تأخير
٢. يتم التسليم لمعيد المقرر مباشرة
٣. تتم أجابه التمرين في نفس ورق الأسئلة

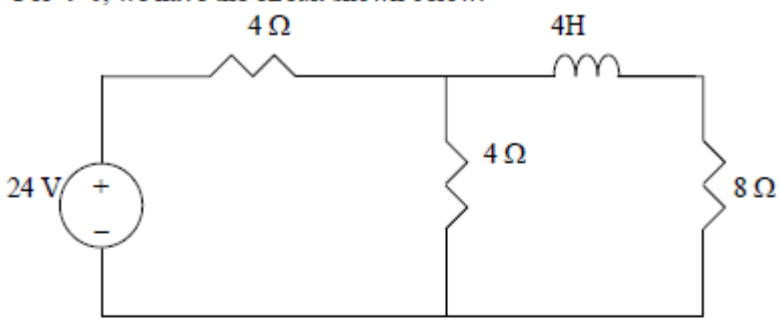
Q1

For the circuit in Fig. 7.91, find i_o for $t > 0$.



Sol 1

For t<0, we have the circuit shown below.



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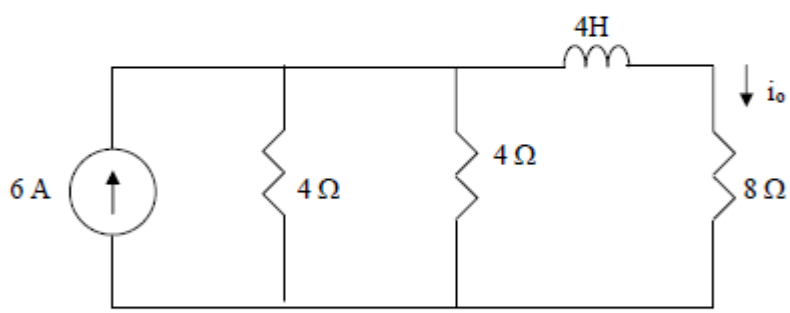


4||4= 4x4/8=2

$i_o(0^-) = [2/(2+8)]6 = 1.2$ A

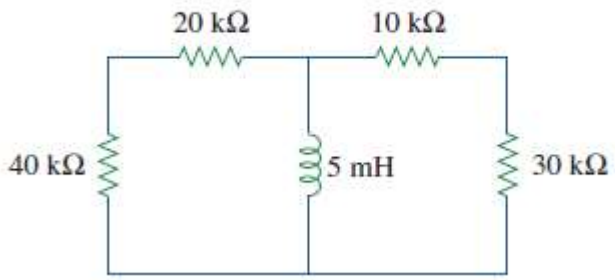
For t >0, we have a source-free RL circuit.

$\tau = \frac{L}{R} = \frac{4}{4+8} = 1/3$ thus,

$$i_o(t) = \mathbf{1.2e^{-3t}\ A}.$$

Q2

Calculate the time constant of the circuit in Fig. 7.94.



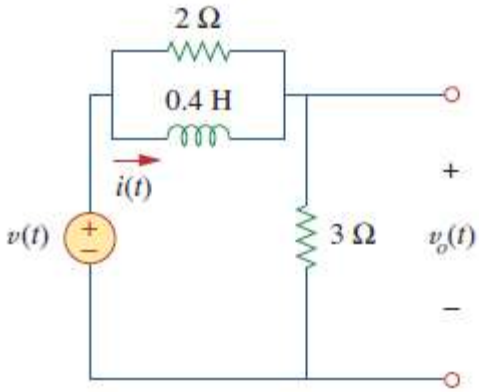
Sol 2

$$R_{Th} = (40+20)//(10+30) = \frac{60x40}{100} = 24k\Omega$$

$$\tau = L/R = \frac{5x10^{-3}}{24x10^{3}} = \underline{0.2083\mu s}$$

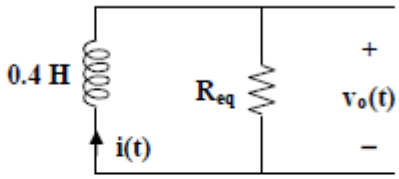
Q3

For the circuit in Fig. 7.98, determine $v_o(t)$ when $i(0) = 5$ A and $v(t) = 0$.



Sol 3

If $v(t) = 0$, the circuit can be redrawn as shown below.



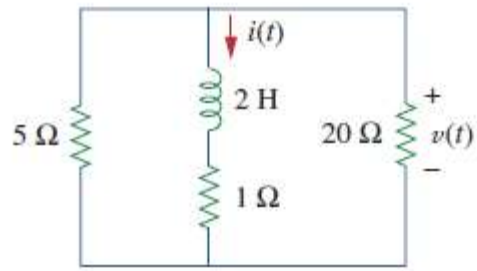
$$R_{eq} = 2 \| 3 = \frac{6}{5}, \qquad \tau = \frac{L}{R} = \frac{2}{5} \times \frac{5}{6} = \frac{1}{3}$$

$$i(t) = i(0)e^{-t/\tau} = 5e^{-3t}$$

$$v_o(t) = -L\frac{di}{dt} = \frac{-2}{5}(-3)5e^{-3t} = \mathbf{6}\,e^{-3t}\ V$$

Q4

Find $i(t)$ and $v(t)$ for $t > 0$ in the circuit of Fig. 7.102 if $i(0) = 10$ A.



Sol 4

$$i(t) = i(0)e^{-t/\tau}, \qquad \tau = \frac{L}{R_{eq}}$$

$$R_{eq} = 5 \,||\, 20 + 1 = 5\,\Omega, \qquad \tau = \frac{2}{5}$$

$$i(t) = \mathbf{10e^{-2.5t}\ A}$$

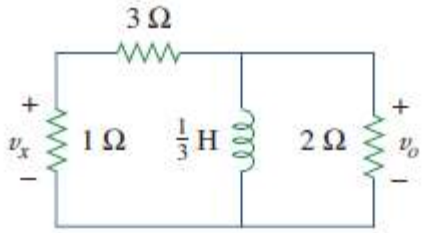
Using current division, the current through the 20 ohm resistor is

$$i_o = \frac{5}{5+20}(-i) = \frac{-i}{5} = -2e^{-2.5t}$$

$$v(t) = 20i_o = \mathbf{-40e^{-2.5t}\ V}$$

Q5

Consider the circuit in Fig. 7.103. Given that $v_o(0) = 10$ V, find v_o and v_x for $t > 0$.



Sol 5

Since the 2 Ω resistor, 1/3 H inductor, and the (3+1) Ω resistor are in parallel, they always have the same voltage.

$$-i = \frac{10}{2} + \frac{10}{3+1} = 7.5 \longrightarrow i(0) = -7.5$$

The Thevenin resistance R_{th} at the inductor's terminals is

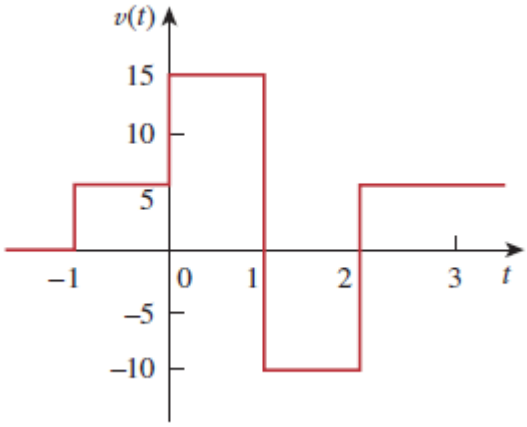
$$R_{th} = 2 \parallel (3+1) = \frac{4}{3}, \qquad \tau = \frac{L}{R_{th}} = \frac{1/3}{4/3} = \frac{1}{4}$$

$$i(t) = i(0)e^{-t/\tau} = -7.5e^{-4t}, \quad t > 0$$

$$v_L = v_o = L\frac{di}{dt} = -7.5(-4)(1/3)e^{-4t}$$

$$v_o = \mathbf{10e^{-4t}\ V}, \quad \mathbf{t > 0}$$

$$v_x = \frac{1}{3+1}v_L = \mathbf{2.5\,e^{-4t}\ V}, \quad \mathbf{t > 0}$$

Q6	Express $v(t)$ in Fig. 7.105 in terms of step functions. 
Sol 6	v(t)= [5u(t+1)+10u(t)–25u(t–1)+15u(t-2)] V